

# Nicholas C. Borcharding, M.D., Ph.D.

Assistant Professor

Department of Pathology and Immunology

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## Positions

- **Clinical Assistant Professor of Pathology and Immunology**, Washington University in St. Louis (2024-07–Present) — St. Louis, MO
- **Head of Computational Biology**, Omniscope (2023-07–2024-06) — Barcelona, Spain
- **Senior Computational Biologist**, Santa Ana Bio (2022-01–2023-06) — Alameda, CA

## Education & Training

### Education

- M.D., Medicine, Carver College of Medicine, University of Iowa, 2020
- Ph.D., Cancer Biology, Carver College of Medicine, University of Iowa, 2020
- M.S., Pathology, University of Iowa, 2014
- B.S., Nutritional Sciences (summa cum laude), Iowa State University, 2012

### Postgraduate Training

- Fellow, Histocompatibility and Immunogenetics, Washington University School of Medicine (2024-07–Present)
- Resident, Clinical Pathology, Washington University School of Medicine (2020-07–2023-05)

### Professional Licensure

- 2023: Medical License, Missouri, #2022049785 (Active)

### Military Experience

- U.S. Marine Corps, Sergeant (2007-05–2013-05), Retired

## **Consulting & Advisory**

- **Development Consultant**, Columbus Instruments, Columbus, OH (2024-12–Present)
- **Scientific Advisor**, Epana Bio, Inc, San Francisco, CA (2024-12–Present)

## **Editorial & Peer Review**

### **Editorial/Review Boards**

Human Immunology (2025)

### **Guest Editor**

Viruses (2025)

### **Ad Hoc Reviews**

Cancer Discovery, Human Immunology, Journal of Immunology, Journal of Open Source Software, Journal of Transplantation, Nucleic Acids Research, Nucleic Acids Research: Genomics & Bioinformatics, Nature Machine Intelligence, Nature Communications, PLoS, PLoS Computational Biology, Science Advances, Science Immunology

## **Service & Committees**

### **Institutional**

- Residency Recruitment Committee, Department of Pathology and Immunology, Washington University St Louis. (2025–Present)
- Graduate Fellowship Review, Division of Biology & Biomedical Sciences, Washington University St Louis. (2025–Present)
- Faculty Search Committee, Department of Pathology and Immunology, Washington University St Louis. (2024–Present)
- Alpha Omega Alpha Selection Committee, Carver College of Medicine, University of Iowa. (2019–2020)
- LCME Accreditation Review Taskforce, Carver College of Medicine, University of Iowa. (2016–2017)
- Medical Education Council, Carver College of Medicine, University of Iowa. (2016–2017)
- Presidential Charter Committee for Recreational Services, University of Iowa. (2015–2018)
- Research Council, University of Iowa (2014–2018)
- Graduate Student Senate, University of Iowa (2013–2014)

## National

- Education Initiatives Committee, American Society for Histocompatibility and Immunogenetics (2024–Present)
- First Aid/USMLErx Student Council (2016–2017)

## Mentorship

### Research Mentorship

- Qile Yang, Undergraduate, 2023–Present: Computational immunology research resulting in two submitted publications
- Isabel Risch, MSTP Student, 2024–Present: HLA-B27 TCR profiling
- Patty Hernandez, Fellow, 2024–Present: HLA eplet comparison of commercial assays

### Career Development

- Haewon Shin, Graduate Student, 2024–Present: Serving on thesis committee

## Awards & Honors

- **2023:** Emerging Generation Award, American Society for Clinical Investigation
- **2021:** Paul E. Strandjord Young Investigator Award, Academy of Clinical and Laboratory Physicians and Scientists
- **2020:** Williams L. Roberts Young Investigator Award with Distinction, Academy of Clinical and Laboratory Physicians and Scientists
- **2020:** Special Achievement in Pathology, Iowa Pathology Society
- **2019:** Alpha Omega Alpha Honor Medical Society, Carver College of Medicine, University of Iowa
- **2018:** Hancher-Finkbine Medallion, University of Iowa
- **2018:** Wilderness Medicine Race, Carver College of Medicine, University of Iowa
- **2017:** Richard G. Lynch, MD Award for Pathology Research, Carver College of Medicine, University of Iowa
- **2017:** Cancer Center Research Award, Carver College of Medicine, University of Iowa
- **2017:** Wilderness Medicine Race, Carver College of Medicine, University of Iowa
- **2015:** ProQuest Hall of Scholars
- **2015:** L.B. Sims Outstanding Master's Thesis Award in Biological Sciences, Graduate College, University of Iowa
- **2015:** Richard G. Lynch, MD Award for Pathology Research, Carver College of Medicine, University of Iowa
- **2014:** Richard G. Lynch, MD Award for Pathology Research, Carver College of Medicine, University of Iowa

- **2013:** Cancer Center Research Award, Carver College of Medicine, University of Iowa
- **2012:** Departmental Scholarly Achievement Award, Department of Food Science and Human Nutrition, Iowa State University
- **2012:** University Graduation Marshall, Iowa State University
- **2012:** Graduation Ceremony Student Address, Department of Human Sciences, Iowa State University
- **2005:** Eagle Scout, Boy Scouts of America

## Professional Memberships

- Member, Siteman Cancer Center at Barnes-Jewish Hospital (2025–Present)
- Member, Antibody Society (2025–Present)
- Member, Academy of Clinical Laboratory Physicians and Scientists (2024–Present)
- Member, American Society for Histocompatibility and Immunogenetics (2024–Present)
- Member, American Board of Pathology (2023–Present)
- Member, Alpha Omega Alpha Honor Society (2019–Present)

## Software

- **scRepertoire** (2020) — Author. Toolkit for single-cell immune repertoire analysis and visualization
- **escape** (2020) — Author. Easy single cell analysis platform for enrichment
- **Trex** (2023) — Author. T-cell receptor embedding and sequence analysis
- **Ibex** (2023) — Author. B-cell receptor embedding and sequence analysis
- **ClamBake** (2023) — Author. Metabolic estimation for CLAM cages, licensed to Columbus Instruments
- **immApex** (2024) — Author. Tools for Adaptive Immune Receptor Sequence-Based Machine and Deep Learning
- **immReferent** (2025) — Author. Reference interface to IMGT and OGRDB for immune receptor and HLA sequences
- **bHIVE** (2025) — Author. B-cell Hybrid Immune Virtual Evolution model for artificial immune system simulation
- **dandelionR** (2025) — Author. Single-cell immune repertoire trajectory analysis in R

## Research Funding

### Institutional

- 2025-2026: *Identification of novel alloantibody targets in lung transplant recipients using phage display immunoprecipitation and sequencing* — Interdivision Translational Research Department of Pathology, Washington University. Role: **Principal Investigator**

- 2022-2023: *Measuring intercellular mitochondria transfer with single-cell sequencing* — Interdivision Translational Research Department of Pathology, Washington University. Role: **Co-Investigator**
- 2017: *Targeting mismatch repair for immunotherapy in basal-like breast cancer* — Oberley Seed Grant for Experimental Therapeutics. Role: **Co-PI**

## National

- 2025-: *Harnessing Single-Cell T Cell-Receptor Sequencing to Accelerate Diagnosis in Inflammatory Arthritis* — Arthritis Research Program Focused Research Award, Department of Defense. Role: **Co-Investigator**
- 2017-2020: *Paracrine non-canonical Wnt signaling in breast cancer* — NIH F30 CA206255. Role: **Principal Investigator**
- 2015-2016: *Paracrine non-canonical Wnt signaling in breast cancer* — American Medical Association Foundation Research Seed Grant. Role: **Principal Investigator**

## Invited Presentations

### Institutional

- 2025: *Computational approaches to the immune synapse*. Rheumatology Grand Rounds, Washington University in St. Louis, MO
- 2023: *Single-cell characterization of the T follicular immune response in COVID-19 vaccination using deep learning*. Physician-Scientist Symposium, St. Louis, MO
- 2023: *Transcriptional heterogeneity in cancer-associated regulatory T cells is predictive of survival*. Single-Cell RNA Sequencing Symposium, Iowa Institute of Genetics

### National

- 2025: *AI for predicting the specificity of TCR*. ASHI Annual Meeting, Orlando FL
- 2025: *Bridging Biology and Bytes: The World of Computational Immunology*. Department of Immunology Grand Rounds, Mayo Clinic, Rochester MN
- 2023: *Single-cell characterization of the T follicular immune response in COVID-19 vaccination using deep learning*. Single Cell Club Montreal Meeting
- 2020: *Single-cell mRNA sequencing of murine and human alopecia areata identifies immune cell profiles predictive of human disease state*. Academy of Clinical Laboratory Physicians and Scientists Meeting, Iowa City IA
- 2019: *Single-cell profiling of cutaneous T-cell lymphoma reveals heterogeneity associated with disease progression*. Society for Investigative Dermatology Meeting, Chicago IL
- 2016: *Paracrine regulation of breast cancer tumorigenesis*. Midwestern Association of Graduate Schools Conference, Chicago IL

## Conference Abstracts

- 2025 A Robust AUC-Based Method for Eplet Calling in HLA Single Antigen Bead Assays: Reducing Variability and Enhancing Cohort-Level Profiling **Borcherding, N.**, Martens, G., Taniguchi, M., & Liu, C. Histocompatibility and Immunogenetics Annual Meeting
- 2025 Developing Flow Cytometry Crossmatch Thresholds: A Statistical Evaluation for Clinical Crossmatching Data **Borcherding, N.**, Dajles, A., Martens, G., Clark, D., Taniguchi, M., & Liu, C. Histocompatibility and Immunogenetics Annual Meeting
- 2024 Liquid biopsy tracking of immunotherapy-induced T cell dynamics in MSS colorectal and endometrial tumors Heyn, H., Melero, J., Deuner, G., Baraibar, I., Grzelak, M., Caratú, G., García-Durán, C., Grau, F., García-Illescas, D., Fariñas, L., Paula Nieto, P., Morabito, S., Rotem, A., Casbas-Hernandez, P., Gros, A., Tabernero, J., Oaknin, A., Nieto, J., **Borcherding, N.**, & Élez, E. ESMO Congress Annual Meeting
- 2024 Spatio-temporal tracking of therapy-induced T cell immunity against pediatric rhabdoid tumors Melero, J., Sentís, I., Cebria-Xart, A., Caratu, G., Grzelak, M., Soto, M., Rodríguez-Hernández, C., Mendizabal-Sasieta, A., Maspero, D., Pascual, A., Perez, J., Galan, R., **Borcherding, N.**, Nieto, J., Avgustinova, A., & Heyn, H. Innovations in Single Cell Omics
- 2024 Ultra deep single-cell T cell receptor sequencing for cancer therapeutics and prognosis Melero, J., Grzelak, M., Pravdyvets, D., Soto, M., Mendizabal-Sasieta, A., Perron, U., **Borcherding, N.**, & Heyn, H. LSX World Congress Annual Meeting
- 2024 Integrated modeling of T cell repertoires to identify clonotype signatures of ICI response Melero, J., Colom-Sanmartí, B., Mendizabal-Sasieta, A., Perron, U., Grzelak, M., Pravdyvets, D., Soto, M., Nieto, J., Vidal, S., Tejpar, S., **Borcherding, N.**, Planas-Rigol, E., & Heyn, H. Immuno-Oncology Summit Europe
- 2024 Quantification of Brain Metastasis-Infiltrating T cells in Blood Using Ultra-Deep Single-Cell T Cell Repertoire Sequencing Planas-Rigol, E., Melero, J., Colom-Sanmartí, B., Bonfill-Teixidor, E., Arias, A., Grzelak, M., Pravdyvets, D., Sant, M., Martelotto, L., **Borcherding, N.**, Heyn, H., & Seoane, J. American Association for Cancer Research Annual Meeting
- 2023 Integrated modeling of T cell repertoires to identify clonotype signatures of ICI response Melero, J., Colom-Sanmartí, B., Mendizabal-Sasieta, A., Perron, U., Grzelak, M., Pravdyvets, D., Soto, M., Nieto, J., Vidal, S., Tejpar, S., **Borcherding, N.**, Planas-Rigol, E., & Heyn, H. ESMO Immuno-Oncology Congress
- 2023 Dietary lipids inhibit mitochondria transfer to macrophages to divert adipocyte-derived mitochondria into the blood **Borcherding, N.**, Jia, W., Giwa, R., Field, R.L., Moley, J.R., Kopecky, B., Chan, M., Yang, B., Sabio, J., Walker, E., Osorio, O., Bredemeyer, A., Pietka, T., Alexander-Brett, J., Morley, S.C., Artyomov, M., Abumrad, N., Schilling, J., Lavine, K., Crewe, C., & Brestoff, J.R. American Society for Clinical Investigation Annual Meeting
- 2023 Autoencoder, a Novel Computational Tool to Score T Cell Clones Demonstrates Biopsy T Cell Clones Are Not Represented in Peripheral Blood **Borcherding, N.**, Leckie-Harre, A., Wu, H., Humphreys, B., & Malone, A. American Transplant Congress Annual Meeting
- 2021 Dissecting the complexity of heart infiltrates in post-infectious myocarditis induced with CVB3 infection by single-cell RNA sequencing analysis Lasrado, N., **Borcherding, N.**, Arugumugam, R., Starr, T.K., & Reddy, J. American Association of Immunologists Annual

Meeting

- 2021 Comprehensive transcriptional and clonotypic analysis of peripheral blood in Sezary syndrome reveals novel expression markers and shifting gene profiles associated with treatment **Borcherding, N.**, Henderson, N., Ortolan, L., Liu, V., Link, B.K., Mangold, A., & Jabbari, A. Society for Investigative Dermatology Annual Meeting
- 2021 Comprehensive transcriptional and clonotypic analysis of peripheral blood in Sezary syndrome reveals novel expression markers and shifting gene profiles associated with treatment **Borcherding, N.**, Henderson, N., Ortolan, L., Liu, V., Link, B.K., Mangold, A., & Jabbari, A. United States and Canada Academy of Pathology Annual Meeting
- 2020 Combining single-cell and AIRR data **Borcherding, N.** Adaptive Immune Receptor Repertoire Society Annual Meeting
- 2020 Preserving the in vivo metabolome and energy-sensitive phosphoproteome requires rapid freezing of tissue samples Rauckhorst, A.J., **Borcherding, N.**, Kraus, A.S., Scerbo, D., & Taylor, E.B. Metabolomics Association of North America Annual Meeting
- 2020 Single-cell mRNA sequencing of murine and human alopecia areata identifies immune cell profiles predictive of human disease state **Borcherding, N.**, Crofts, S., Ortolan, L., Bormann, N., & Jabbari, A. Academy of Clinical Laboratory Physicians and Scientists Annual Meeting, Iowa City, IA
- 2020 Immune suppressive deficit in human Tc1 cells secondary to IL-12-induced pathways Renavikar, P., Sinha, S., Brate, A., Crawford, M., **Borcherding, N.**, Steward, S., & Karandikar, N. Academy of Clinical Laboratory Physicians and Scientists Annual Meeting, Iowa City, IA
- 2020 Virtual Anatomy Videos for Pre-Lab Preparation: Does Usage Correlate with Grade Outcomes Hoffmann, D., Feagle, T., & **Borcherding, N.** Experimental Biology Annual Meeting, San Diego, CA (Canceled due to COVID-19)
- 2020 WNT/ -Catenin Signaling Correlates with Improved Survival in Luminal A Breast Cancer Cole, K., Councilman, K., Zhang, W., & **Borcherding, N.** USCAP Annual Meeting, Los Angeles, CA
- 2019 Mapping immune landscape in clear cell renal carcinoma by single-cell genomics Vishwakarma, A., **Borcherding, N.**, Chementi, M., Vishwakarma, P., Nepple, K., Salem, A., Jenkins, R.W., Zhang, W., & Zakharia, Y. AACR Special Conference on Tumor Immunology and Immunotherapy, Boston, MA
- 2019 Single-cell profiling of cutaneous T-cell lymphoma reveals underlying heterogeneity associated with disease progression **Borcherding, N.**, Voigt, A., Liu, V., Link, B.K., Zhang, W., & Jabbari, A. Society for Investigative Dermatology Annual Meeting, Chicago, IL
- 2018 Using data analytics to predict and improve cancer immunotherapy response **Borcherding, N.**, Bormann, N., & Zhang, W. American Physician Scientist Association Midwest Regional Meeting, Iowa City, IA
- 2017 Targeting mismatch repair for basal-like breast cancer **Borcherding, N.**, Jo, S., & Zhang, W. Cancer Biology Training Consortium Annual Meeting, Portland, OR
- 2017 Students Prefer 3D Anatomy Videos for Prelab Preparation Compared to Traditional Resources and Usage is Related to Class Performance Feagle, T., **Borcherding, N.**, & Hoffmann, D. Experimental Biology Conference, Chicago, IL

- 2017 IL-1 promotes obesity-driven breast cancer progression through the upregulation of Angptl4 in adipocytes Kolb, R., Kluz, P., Wei, T.Z., Bormann, N., **Borcherding, N.**, Markan, K., Pothoff, B., Tan, N.S., Sutterwala, F., & Zhang, W. Inflammation-driven Cancer: Mechanisms to Therapy Keystone Symposia, Keystone, CO
- 2016 Calpain-5 expression in the retina localizes to photoreceptor synapses Schaefer, K.A., Toral, M., Velez, G., Cox, A., Baker, S., **Borcherding, N.**, Colgan, D.F., Smits, M.M., Bondada, V., Mashburn, C.B., Yu, C., Geddes, J., Tsang, S.H., Bassuk, A.G., & Mahajan, V.B. FASEB Conference on the Biology of Calpains in Health and Disease, Big Sky, MT
- 2016 Obesity-induced Nlr4 inflammasome promotes angiogenesis in breast cancer Kolb, R., Phan, L., **Borcherding, N.**, Liu, Y., Yuan, F., Janowski, A.M., Xie, Q., Markan, K., Li, W., Pothoff, M., Fuentes-Mattei, E., Ellies, L., Knudson, M., Lee, M., Yeung, S., Cassel, S., Sutterwala, F., & Zhang, W. AACR Special Conference: The Function of Tumor Microenvironment in Cancer, San Diego, CA
- 2015 NLRC4 inflammasome promotes breast cancer progression in diet-induced obese mice Kolb, R., **Borcherding, N.**, Liu, Y., Yuan, F., Xie, Q., Sutterwala, F., & Zhang, W. American Association for Cancer Research Annual Meeting, Philadelphia, PA
- 2015 Paracrine Wnt5a signaling inhibits the expansion of tumor-initiating cells via Ryk/TGF R/Smad2 **Borcherding, N.**, Kusner, D., Kolb, R., Xie, Q., & Zhang, W. ASCI/AAP/APSA Joint Meeting, Chicago, IL
- 2014 Wnt5a/ROR1 Axis in Triple Negative Breast Cancer Progression and Potential Therapy **Borcherding, N.**, Kusner, D., Kolb, R., Xie, Q., & Zhang, W. American Association for Cancer Research Annual Meeting, San Diego, CA
- 2014 Inflammasome activation in obesity-associated breast cancer progression Kolb, R., Liu, Y., Xie, Q., **Borcherding, N.**, Li, W., & Zhang, W. American Association for Cancer Research Annual Meeting, San Diego, CA
- 2014 CD177, A novel metastasis suppressor of breast cancer Xie, Q., **Borcherding, N.**, Kolb, R., & Zhang, W. American Association for Cancer Research Meeting, San Diego, CA

## Publications

1. Smazal AL, **Borcherding NC**, Anderegg AS, Schalinske KL, Whitley EM, Rowling MJ. Dietary resistant starch prevents urinary excretion of 25-hydroxycholecalciferol and vitamin D-binding protein in type 1 diabetic rats. *The Journal of nutrition*. 2013;143(7):1123-8.
2. Zhang W, Tan W, Wu X, Poustovoitov M, Strasner A, Li W, **Borcherding N**, Ghassemian M, Karin M. A NIK-IKK module expands ErbB2-induced tumor-initiating cells by stimulating nuclear export of p27/Kip1. *Cancer cell*. 2013;23(5):647-59.
3. **Borcherding N**, Kusner D, Liu G, Zhang W. ROR1, an embryonic protein with an emerging role in cancer biology. *Protein & cell*. 2014;5(7):496-02.
4. Reed SM, Hagen J, Muniz VP, Rosean TR, **Borcherding N**, Sciegienka S, Goeken JA, Naumann PW, Zhang W, Tompkins VS, Janz S, Meyerholz DK, Quelle DE. NIAM-deficient mice are predisposed to the development of proliferative lesions including B-cell lymphomas. *PloS one*. 2014;9(11):e112126.



5. Wu X, Zhang W, Font-Burgada J, Palmer T, Hamil AS, Biswas SK, Poidinger M, **Borcherding N**, Xie Q, Ellies LG, Lytle NK, Wu L, Fox RG, Yang J, Dowdy SF, Reya T, Karin M. Ubiquitin-conjugating enzyme Ubc13 controls breast cancer metastasis through a TAK1-p38 MAP kinase cascade. *Proceedings of the National Academy of Sciences of the United States of America*. 2014;111(38):13870-5.
6. **Borcherding N**, Bormann N, Kusner D, Kolb R, Zhang W. Transcriptome analysis of basal and luminal tumor-initiating cells in ErbB2-driven breast cancer. *Genomics data*. 2015;4:119–22.
7. **Borcherding N**, Kusner D, Kolb R, Xie Q, Li W, Yuan F, Velez G, Askeland R, Weigel RJ, Zhang W. Paracrine WNT5A Signaling Inhibits Expansion of Tumor-Initiating Cells. *Cancer research*. 2015;75(10):1972–82.
8. Mahauad-Fernandez WD, **Borcherding NC**, Zhang W, Okeoma CM. Bone marrow stromal antigen 2 (BST-2) DNA is demethylated in breast tumors and breast cancer cells. *PloS one*. 2015;10(4):e0123931.
9. Xie Q, Klesney-Tait J, Keck K, Parlet C, **Borcherding N**, Kolb R, Li W, Tygrett L, Waldschmidt T, Olivier A, Chen S, Liu G, Li X, Zhang W. Characterization of a novel mouse model with genetic deletion of CD177. *Protein & cell*. 2015;6(2):117–26.
10. Kusner D, **Borcherding N**, Zhang W. Paracrine WNT5A signaling in healthy and neoplastic mammary tissue. *Molecular & cellular oncology*. 2016;3(1):e1040145.
11. Schaefer KA, Toral MA, Velez G, Cox AJ, Baker SA, **Borcherding NC**, Colgan DF, Bondada V, Mashburn CB, Yu C, Geddes JW, Tsang SH, Bassuk AG, Mahajan VB. Calpain-5 Expression in the Retina Localizes to Photoreceptor Synapses. *Investigative ophthalmology & visual science*. 2016;57(6):2509–21.
12. **Borcherding N**, Cole K, Kluz P, Jorgensen M, Kolb R, Bellizzi A, Zhang W. Re-Evaluating E-Cadherin and -Catenin: A Pan-Cancer Proteomic Approach with an Emphasis on Breast Cancer. *The American journal of pathology*. 2018;188(8):1910–20.
13. **Borcherding N**, Kolb R, Gullicksrud J, Vikas P, Zhu Y, Zhang W. Keeping Tumors in Check: A Mechanistic Review of Clinical Response and Resistance to Immune Checkpoint Blockade in Cancer. *Journal of molecular biology*. 2018;430(14):2014–29.
14. Fleagle TR, **Borcherding NC**, Harris J, Hoffmann DS. Application of flipped classroom pedagogy to the human gross anatomy laboratory: Student preferences and learning outcomes. *Anatomical sciences education*. 2018;11(4):385–96.
15. Liu Q, Kulak MV, **Borcherding N**, Maina PK, Zhang W, Weigel RJ, Qi HH. A novel HER2 gene body enhancer contributes to HER2 expression. *Oncogene*. 2018;37(5):687–94.
16. Sinha S, **Borcherding N**, Renavikar PS, Crawford MP, Tsalikian E, Tansey M, Shivapour ET, Bittner F, Kamholz J, Olalde H, Gibson E, Karandikar NJ. An autoimmune disease risk SNP, rs2281808, in SIRPG is associated with reduced expression of SIRP and heightened effector state in human CD8 T-cells. *Scientific reports*. 2018;8(1):15440.
17. Vikas P, **Borcherding N**, Zhang W. The clinical promise of immunotherapy in triple-negative breast cancer. *Cancer management and research*. 2018;10:6823–33.
18. Bi J, Yang S, Li L, Dai Q, **Borcherding N**, Wagner BA, Buettner GR, Spitz DR, Leslie KK, Zhang J, Meng X. Metadherin enhances vulnerability of cancer cells to ferroptosis. *Cell death & disease*. 2019;10(10):682.

19. **Borcherding N**, Voigt AP, Liu V, Link BK, Zhang W, Jabbari A. Single-Cell Profiling of Cutaneous T-Cell Lymphoma Reveals Underlying Heterogeneity Associated with Disease Progression. *Clinical cancer research : an official journal of the American Association for Cancer Research*. 2019;25(10):2996–05.
20. Kolb R, Kluz P, Tan ZW, **Borcherding N**, Bormann N, Vishwakarma A, Balczak L, Zhu P, Davies BS, Gourronc F, Liu L, Ge X, Jiang B, Gibson-Corley K, Klingelhutz A, Tan NS, Zhu Y, Sutterwala FS, Shen X, Zhang W. Obesity-associated inflammation promotes angiogenesis and breast cancer via angiopoietin-like 4. *Oncogene*. 2019;38(13):2351–63.
21. Liu Q, **Borcherding N**, Shao P, Cao H, Zhang W, Qi HH. Identification of novel TGF-regulated genes with pro-migratory roles. *Biochimica et biophysica acta. Molecular basis of disease*. 2019;1865(12):165537.
22. Pandey G, **Borcherding N**, Kolb R, Kluz P, Li W, Sugg S, Zhang J, Lai DA, Zhang W. ROR1 Potentiates FGFR Signaling in Basal-Like Breast Cancer. *Cancers*. 2019;11(5).
23. **Borcherding N**, Bormann NL, Kraus G. scRepertoire: An R-based toolkit for single-cell immune receptor analysis. *F1000Research*. 2020;9:47.
24. **Borcherding N**, Crotts SB, Ortolan LS, Henderson N, Bormann NL, Jabbari A. A transcriptomic map of murine and human alopecia areata. *JCI insight*. 2020;5(13).
25. **Borcherding N**, Jethava Y, Vikas P. Repurposing Anti-Cancer Drugs for COVID-19 Treatment. *Drug design, development and therapy*. 2020;14:5045–58.
26. Crawford MP, Sinha S, Renavikar PS, **Borcherding N**, Karandikar NJ. CD4 T cell-intrinsic role for the T helper 17 signature cytokine IL-17: Effector resistance to immune suppression. *Proceedings of the National Academy of Sciences of the United States of America*. 2020;117(32):19408–14.
27. Kluz PN, Kolb R, Xie Q, **Borcherding N**, Liu Q, Luo Y, Kim M, Wang L, Zhang Y, Li W, Stipp C, Gibson-Corley KN, Zhao C, Qi HH, Bellizzi A, Tao AW, Sugg S, Weigel RJ, Zhou D, Shen X, Zhang W. Cancer cell-intrinsic function of CD177 in attenuating  $\beta$ -catenin signaling. *Oncogene*. 2020;39(14):2877–89.
28. Liu Q, **Borcherding NC**, Shao P, Maina PK, Zhang W, Qi HH. Contribution of synergism between PHF8 and HER2 signalling to breast cancer development and drug resistance. *EBioMedicine*. 2020;51:102612.
29. Renavikar PS, Sinha S, Brate AA, **Borcherding N**, Crawford MP, Steward-Tharp SM, Karandikar NJ. IL-12-Induced Immune Suppressive Deficit During CD8+ T-Cell Differentiation. *Frontiers in immunology*. 2020;11:568630.
30. Swami U, Chennamadhavuni A, **Borcherding N**, Bossler AD, Mott SL, Garje R, Zakharia Y, Milhem M. Multivariable Analysis of 169 Cases of Advanced Cutaneous Melanoma to Evaluate Antibiotic Exposure as Predictor of Survival to Anti-PD-1 Based Immunotherapies. *Antibiotics (Basel, Switzerland)*. 2020;9(11).
31. Vikas P, **Borcherding N**, Chennamadhavuni A, Garje R. Therapeutic Potential of Combining PARP Inhibitor and Immunotherapy in Solid Tumors. *Frontiers in oncology*. 2020;10:570.
32. Wu VT, Kiriazov B, Koch KE, Gu VW, Beck AC, **Borcherding N**, Li T, Addo P, Wehrspan ZJ, Zhang W, Braun TA, Brown BJ, Band V, Band H, Kulak MV, Weigel RJ. A \*TFAP2C\* Gene Signature Is Predictive of Outcome in HER2-Positive Breast Cancer. *Molecular cancer research : MCR*. 2020;18(1):46–56.

33. Xiu Y, Dong Q, Fu L, Bossler A, Tang X, Boyce B, **Borcherding N**, Leidinger M, Sardina JL, Xue H, Li Q, Feldman A, Aifantis I, Boccalatte F, Wang L, Jin M, Khoury J, Wang W, Hu S, Yuan Y, Wang E, Yuan J, Janz S, Colgan J, Habelhah H, Waldschmidt T, Müschen M, Bagg A, Darbro B, Zhao C. Coactivation of NF- B and Notch signaling is sufficient to induce B-cell transformation and enables B-myeloid conversion. *Blood*. 2020;135(2):108–20.
34. Amanat F, Thapa M, Lei T, Ahmed SMS, Adelsberg DC, Carreño JM, Strohmeier S, Schmitz AJ, Zafar S, Zhou JQ, Rijnink W, Alshammery H, **Borcherding N**, Reiche AG, Srivastava K, Sordillo EM, van Bakel H, Initiative PV, Turner JS, Bajic G, Simon V, Ellebedy AH, Krammer F. SARS-CoV-2 mRNA vaccination induces functionally diverse antibodies to NTD, RBD, and S2. *Cell*. 2021;184(15):3936-3948.e10.
35. **Borcherding N**, Gronowski AM. Commentary on a Case of Unexpected Hyperglycemia. *Clinical chemistry*. 2021;67(8):1060–61.
36. **Borcherding N**, Vishwakarma A, Voigt AP, Bellizzi A, Kaplan J, Nepple K, Salem AK, Jenkins RW, Zakharia Y, Zhang W. Mapping the immune environment in clear cell renal carcinoma by single-cell genomics. *Communications biology*. 2021;4(1):122.
37. Cheng Y, **Borcherding N**, Ogunsakin A, Lemke-Miltner CD, Gibson-Corley KN, Rajan A, Choi AB, Wongpattaraworakul W, Chan CHF, Salem AK, Weiner GJ, Simons AL. The anti-tumor effects of cetuximab in combination with VTX-2337 are T cell dependent. *Scientific reports*. 2021;11(1):1535.
38. Fujiwara Y, Torphy RJ, Sun Y, Miller EN, Ho F, **Borcherding N**, Wu T, Torres RM, Zhang W, Schulick RD, Zhu Y. The GPR171 pathway suppresses T cell activation and limits antitumor immunity. *Nature communications*. 2021;12(1):5857.
39. Gu VW, Cho E, Thompson DT, Cassady VC, **Borcherding N**, Koch KE, Wu VT, Lorenzen AW, van der Heide DM, White JR, Kulak MV, Williams T, Zhang W, Weigel RJ. AP-2 Is Required for Maintenance of Multipotent Mammary Stem Cells. *Stem cell reports*. 2021;16(1):106–19.
40. Kim M, **Borcherding N**, Ahmed KK, Voigt AP, Vishwakarma A, Kolb R, Kluz PN, Pandey G, De U, Drashansky T, Helm EY, Zhang X, Gibson-Corley KN, Klesney-Tait J, Zhu Y, Lu J, Lu J, Huang X, Xiang H, Cheng J, Wang D, Wang Z, Tang J, Hu J, Wang Z, Liu H, Li M, Zhuang H, Avram D, Zhou D, Bacher R, Zheng SG, Wu X, Zakharia Y, Zhang W. CD177 modulates the function and homeostasis of tumor-infiltrating regulatory T cells. *Nature communications*. 2021;12(1):5764.
41. Kim M, Jin Z, Kolb R, **Borcherding N**, Chatzkel JA, Falzarano SM, Zhang W. Updates on Immunotherapy and Immune Landscape in Renal Clear Cell Carcinoma. *Cancers*. 2021;13(22).
42. Kolb HR, **Borcherding N**, Zhang W. Understanding and Targeting Human Cancer Regulatory T Cells to Improve Therapy. *Advances in experimental medicine and biology*. 2021;1278:229–56.
43. Kolb R, De U, Khan S, Luo Y, Kim M, Yu H, Wu C, Mo J, Zhang X, Zhang P, Zhang X, **Borcherding N**, Koppel D, Fu Y, Zheng SG, Avram D, Zheng G, Zhou D, Zhang W. Proteolysis-targeting chimera against BCL-X<sub>L</sub> destroys tumor-infiltrating regulatory T cells. *Nature communications*. 2021;12(1):1281.
44. Maharjan CK, Mo J, Wang L, Kim M, Wang S, **Borcherding N**, Vikas P, Zhang W. Natural

- and Synthetic Estrogens in Chronic Inflammation and Breast Cancer. *Cancers*. 2021;14(1).
45. Mathew NR, Jayanthan JK, Smirnov IV, Robinson JL, Axelsson H, Nakka SS, Emmanouilidi A, Czarnewski P, Yewdell WT, Schön K, Lebrero-Fernández C, Bernasconi V, Rodin W, Harandi AM, Lycke N, **Borcherding N**, Yewdell JW, Greiff V, Bemark M, Angeletti D. Single-cell BCR and transcriptome analysis after influenza infection reveals spatiotemporal dynamics of antigen-specific B cells. *Cell reports*. 2021;35(12):109286.
  46. Merritt N, Garcia K, Rajendran D, Lin Z, Zhang X, Mitchell KA, **Borcherding N**, Fullenkamp C, Chimenti MS, Gingras A, Harvey KF, Tanas MR. TAZ-CAMTA1 and YAP-TFE3 alter the TAZ/YAP transcriptome by recruiting the ATAC histone acetyltransferase complex. *eLife*. 2021;10.
  47. Reynolds D, Vazquez Guillaumet C, Day A, **Borcherding N**, Vazquez Guillaumet R, Choreño-Parra JA, House SL, O'Halloran JA, Zúñiga J, Ellebedy AH, Byers DE, Mudd PA. Comprehensive Immunologic Evaluation of Bronchoalveolar Lavage Samples from Human Patients with Moderate and Severe Seasonal Influenza and Severe COVID-19. *Journal of immunology (Baltimore, Md. : 1950)*. 2021;207(5):1229–38.
  48. Subramani S, Bellizzi AM, **Borcherding N**, Kao SC, Dillon J, Howe J, Norris AW, Tansey MJ, Pinnaro CT. Hypoglycemia secondary to insulinoma masking the onset of type 1 diabetes in an adolescent. *Clinical case reports*. 2021;9(9):e04868.
  49. Zhao J, Xiu Y, Fu L, Dong Q, **Borcherding N**, Wang Y, Li Q, De Silva NS, Klein U, Boyce BF, Zhao C. TIFAB accelerates MLL-AF9-Induced acute myeloid leukemia through upregulation of HOXA9. *iScience*. 2021;24(12):103425.
  50. Alam J, Yazdanpanah G, Ratnapriya R, **Borcherding N**, de Paiva CS, Li D, Guimaraes de Souza R, Yu Z, Pflugfelder SC. IL-17 Producing Lymphocytes Cause Dry Eye and Corneal Disease With Aging in RXR Mutant Mouse. *Frontiers in medicine*. 2022;9:849990.
  51. Alam J, Yazdanpanah G, Ratnapriya R, **Borcherding N**, de Paiva CS, Li D, Pflugfelder SC. Single-cell transcriptional profiling of murine conjunctival immune cells reveals distinct populations expressing homeostatic and regulatory genes. *Mucosal immunology*. 2022;15(4):620–28.
  52. **Borcherding N**, Jia W, Giwa R, Field RL, Moley JR, Kopecky BJ, Chan MM, Yang BQ, Sabio JM, Walker EC, Osorio O, Bredemeyer AL, Pietka T, Alexander-Brett J, Morley SC, Artyomov MN, Abumrad NA, Schilling J, Lavine K, Crewe C, Brestoff JR. Dietary lipids inhibit mitochondria transfer to macrophages to divert adipocyte-derived mitochondria into the blood. *Cell metabolism*. 2022;34(10):1499-1513.e8.
  53. Dong Q, Xiu Y, Wang Y, Hodgson C, **Borcherding N**, Jordan C, Buchanan J, Taylor E, Wagner B, Leidinger M, Holman C, Thiele DJ, O'Brien S, Xue H, Zhao J, Li Q, Meyerson H, Boyce BF, Zhao C. HSF1 is a driver of leukemia stem cell self-renewal in acute myeloid leukemia. *Nature communications*. 2022;13(1):6107.
  54. Lander VE, Belle JI, Kingston NL, Herndon JM, Hogg GD, Liu X, Kang L, Knolhoff BL, Bogner SJ, Baer JM, Zuo C, **Borcherding NC**, Lander DP, Mpoy C, Scott J, Zahner M, Rogers BE, Schwarz JK, Kim H, DeNardo DG. Stromal Reprogramming by FAK Inhibition Overcomes Radiation Resistance to Allow for Immune Priming and Response to Checkpoint Blockade. *Cancer discovery*. 2022;12(12):2774–99.
  55. Lasrado N, **Borcherding N**, Arumugam R, Starr TK, Reddy J. Dissecting the cellular

- landscape and transcriptome network in viral myocarditis by single-cell RNA sequencing. *iScience*. 2022;25(3):103865.
56. Mathew NR, Jayanthan JK, Smirnov IV, Robinson JL, Axelsson H, Nakka SS, Emmanouilidi A, Czarnewski P, Yewdell WT, Schön K, Lebrero-Fernández C, Bernasconi V, Rodin W, Harandi AM, Lycke N, **Borcherding N**, Yewdell JW, Greiff V, Bemerk M, Angeletti D. Single-cell BCR and transcriptome analysis after influenza infection reveals spatiotemporal dynamics of antigen-specific B cells. *Cell reports*. 2022;41(9):111764.
  57. Rauckhorst AJ, **Borcherding N**, Pape DJ, Kraus AS, Scerbo DA, Taylor EB. Mouse tissue harvest-induced hypoxia rapidly alters the in vivo metabolome, between-genotype metabolite level differences, and  $^{13}\text{C}$ -tracing enrichments. *Molecular metabolism*. 2022;66:101596.
  58. Rosina M, Ceci V, Turchi R, Chuan L, **Borcherding N**, Sciarretta F, Sánchez-Díaz M, Tortolici F, Karlinsey K, Chiurchiù V, Fuoco C, Giwa R, Field RL, Audano M, Arena S, Palma A, Riccio F, Shamsi F, Renzone G, Verri M, Crescenzi A, Rizza S, Faienza F, Filomeni G, Kooijman S, Rufini S, de Vries AAF, Scaloni A, Mitro N, Tseng Y, Hidalgo A, Zhou B, Brestoff JR, Aquilano K, Lettieri-Barbato D. Ejection of damaged mitochondria and their removal by macrophages ensure efficient thermogenesis in brown adipose tissue. *Cell metabolism*. 2022;34(4):533-548.e12.
  59. Shrode RL, Cady N, Jensen SN, **Borcherding N**, Mangalam AK. Isoflavone consumption reduces inflammation through modulation of phenylalanine and lipid metabolism. *Metabolomics : Official journal of the Metabolomic Society*. 2022;18(11):84.
  60. Andreatta M, Gueguen P, **Borcherding N**, Carmona SJ. T Cell Clonal Analysis Using Single-cell RNA Sequencing and Reference Maps. *Bio-protocol*. 2023;13(16):e4735.
  61. Baer JM, Zuo C, Kang L, de la Lastra AA, **Borcherding NC**, Knolhoff BL, Bogner SJ, Zhu Y, Yang L, Laurent J, Lewis MA, Zhang N, Kim K, Fields RC, Yokoyama WM, Mills JC, Ding L, Randolph GJ, DeNardo DG. Fibrosis induced by resident macrophages has divergent roles in pancreas inflammatory injury and PDAC. *Nature immunology*. 2023;24(9):1443–57.
  62. **Borcherding N**, Brestoff JR. The power and potential of mitochondria transfer. *Nature*. 2023;623(7986):283–91.
  63. **Borcherding N**, Severson KJ, Henderson N, Ortolan LS, Rosenthal AC, Bellizzi AM, Liu V, Link BK, Mangold AR, Jabbari A. Single-cell analysis of Sézary syndrome reveals novel markers and shifting gene profiles associated with treatment. *Blood advances*. 2023;7(3):321–35.
  64. Crawford MP, **Borcherding N**, Karandikar NJ. IL-17 cytokines preferentially act on naïve CD4+ T cells with the IL-17AF heterodimer inducing the greatest functional changes. *PloS one*. 2023;18(4):e0285166.
  65. He M, Roussak K, Ma F, **Borcherding N**, Garin V, White M, Schutt C, Jensen TI, Zhao Y, Iberg CA, Shah K, Bhatia H, Korenfeld D, Dinkel S, Gray J, Ulezko Antonova A, Ferris S, Donermeyer D, Lindestam Arlehamn C, Gubin MM, Luo J, Gorvel L, Pellegrini M, Sette A, Tung T, Bak R, Modlin RL, Fields RC, Schreiber RD, Allen PM, Klechevsky E. CD5 expression by dendritic cells directs T cell immunity and sustains immunotherapy responses. *Science (New York, N.Y.)*. 2023;379(6633):eabg2752.
  66. Herzog BH, Baer JM, **Borcherding N**, Kingston NL, Belle JI, Knolhoff BL, Hogg GD, Ahmad F, Kang L, Petrone J, Lin C, Govindan R, DeNardo DG. Tumor-associated fibrosis

- impairs immune surveillance and response to immune checkpoint blockade in non-small cell lung cancer. *Science translational medicine*. 2023;15(699):eadh8005.
67. Lefebvre MN, **Borcherding N**, Reis RJ, Mou E, Liu V, Jabbari A. Molecular techniques drive cutting edge advancements in management of cutaneous T cell lymphoma. *Frontiers in immunology*. 2023;14:1228563.
  68. Liu X, Hogg GD, Zuo C, **Borcherding NC**, Baer JM, Lander VE, Kang L, Knolhoff BL, Ahmad F, Osterhout RE, Galkin AV, Bruey J, Carter LL, Mpoy C, Vij KR, Fields RC, Schwarz JK, Park H, Gupta V, DeNardo DG. Context-dependent activation of STING-interferon signaling by CD11b agonists enhances anti-tumor immunity. *Cancer cell*. 2023;41(6):1073-1090.e12.
  69. Mudd P, **Borcherding N**, Kim W, Quinn M, Han F, Zhou J, Sturtz A, Schmitz A, Lei T, Schattgen S, Klebert M, Suessen T, Middleton W, Goss C, Liu C, Crawford J, Thomas P, Teehey S, Presti R, O'Halloran J, Turner J, Ellebedy A. Antigen-specific CD4<sup>+</sup> T cells exhibit distinct transcriptional phenotypes in the lymph node and blood following vaccination in humans. *Research square*. 2023.
  70. Westerhof LM, Noonan J, Hargrave KE, Chimbayo ET, Cheng Z, Purnell T, Jackson MR, **Borcherding N**, MacLeod MKL. Multifunctional cytokine production marks influenza A virus-specific CD4 T cells with high expression of survival molecules. *European journal of immunology*. 2023;53(11):e2350559.
  71. **Borcherding N**, Kim W, Quinn M, Han F, Zhou JQ, Sturtz AJ, Schmitz AJ, Lei T, Schattgen SA, Klebert MK, Suessen T, Middleton WD, Goss CW, Liu C, Crawford JC, Thomas PG, Teehey SA, Presti RM, O'Halloran JA, Turner JS, Ellebedy AH, Mudd PA. CD4<sup>+</sup> T cells exhibit distinct transcriptional phenotypes in the lymph nodes and blood following mRNA vaccination in humans. *Nature immunology*. 2024;25(9):1731–41.
  72. Irac SE, Soon MSF, **Borcherding N**, Tuong ZK. Single-cell immune repertoire analysis. *Nature methods*. 2024;21(5):777–92.
  73. Kim M, **Borcherding N**, Song W, Kolb R, Zhang W. Leveraging single-cell transcriptomic data to uncover immune suppressive cancer cell subsets in triple-negative canine breast cancers. *Frontiers in veterinary science*. 2024;11:1434617.
  74. Kim M, De U, **Borcherding N**, Wang L, Paek J, Bhattacharyya I, Yu Q, Kolb R, Drashansky T, Thatayatikom A, Zhang W, Cha S. Single-cell transcriptomics unveil profiles and interplay of immune subsets in rare autoimmune childhood Sjögren's disease. *Communications biology*. 2024;7(1):481.
  75. Mazziotta F, Biavati L, Rimando J, Rutella S, **Borcherding N**, Parbhoo S, Mukhopadhyay R, Chowdhury S, Knaus HA, Valent P, Hackl H, Borrello IM, Blazar BR, Hatzi K, Gojo I, Luznik L. CD8<sup>+</sup> T-cell differentiation and dysfunction inform treatment response in acute myeloid leukemia. *Blood*. 2024;144(11):1168–82.
  76. Nakai R, Varnum S, Field RL, Shi H, Giwa R, Jia W, Krysa SJ, Cohen EF, **Borcherding N**, Saneto RP, Tsai RC, Suganuma M, Ohta H, Yokota T, Brestoff JR. Mitochondria transfer-based therapies reduce the morbidity and mortality of Leigh syndrome. *Nature metabolism*. 2024;6(10):1886–96.
  77. Pothuri VS, Hogg GD, Conant L, **Borcherding N**, James CA, Mudd J, Williams G, Seo YD, Hawkins WG, Pillarisetty VG, DeNardo DG, Fields RC. Intratumoral T-cell receptor reper-

- toire composition predicts overall survival in patients with pancreatic ductal adenocarcinoma. *Oncoimmunology*. 2024;13(1):2320411.
78. Corvino D, Batstone M, Hughes BGM, Kempchen T, Ng SS, Salim N, Schneppenheim F, Rommel D, Kumar A, Pearson S, Madore J, Koufariotis LT, Steinheuer LM, Pathirana D, Thurley K, Hölzel M, **Borcherding N**, Braun M, Bald T. Type I Interferon Drives a Cellular State Inert to TCR-Stimulation and Could Impede Effective T-Cell Differentiation in Cancer. *European journal of immunology*. 2025;55(1):e202451371.
  79. Hernandez PV, Shen M, Tang MS, Taniguchi M, **Borcherding N**, Liu C. Antigen and eplet coverage by representative solid-phase immunoassays for anti-HLA antibody screen. *Human immunology*. 2025;86(4):111339.
  80. McGivney GR, Brockman QR, **Borcherding N**, Scherer A, Rauckhorst AJ, Gutierrez WR, Solst SR, Heer CD, Warriar A, Floyd W, Kirsch DG, Knepper-Adrian VL, Lavery EA, Roughton GA, Spitz DR, Taylor EB, Dodd RD. Somatic CRISPR tumorigenesis and multiomic analysis reveal a pentose phosphate pathway disruption vulnerability in MPNSTs. *Science advances*. 2025;11(33):eadu2906.
  81. Upadhye M, Wilhelm CR, Rogers KJ, Vemulawada C, **Borcherding N**, Boyden AW, Legge KL, Karandikar NJ. Myelin-reactive CD8<sup>+</sup> T cells influence conventional dendritic cell subsets towards a mature and regulatory phenotype in experimental autoimmune encephalomyelitis. *Journal of neuroinflammation*. 2025;22(1):54.
  82. Wang Y, Xiu Y, Dong Q, Zhao J, Neumbo K, Miyagi M, **Borcherding N**, Fu L, De Celis H, Pintozzi N, Starczynowski DT, Zhao C. TIFAB modulates metabolic pathways in KMT2A::MLLT3-induced AML through HNF4A. *Blood advances*. 2025;9(4):844–55.
  83. Yang Q, Safina KR, Nguyen KDQ, Tuong ZK, **Borcherding N**. scRepertoire 2: Enhanced and efficient toolkit for single-cell immune profiling. *PLoS computational biology*. 2025;21(6):e1012760.
  84. Yu J, Xu X, **Borcherding N**, Tuong ZK. *dandelionR*: Single-cell immune repertoire trajectory analysis in R. *Computational and structural biotechnology journal*. 2025;27:2890–97.